PROPOSED THE NEW DESIGN NEW AIR AND DEIONIZED WATER PIPING SYSTEM AT FKKSA'S LABORATORY

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ABSTRACT

The air and deionized water piping recently is drawn 3D by using Plant Design Management System (PDMS). The PDMS is used worldwide not only for piping design but it can design as big as plant, factory and offshore platform. The main objective for this research is to design new air and deionized water piping system for improving recent piping system to make sure it can support the increasing demand of deionized water and air due to new equipments installation. The faculty of chemical and natural resources (FKKSA) laboratory is used as model for the drawing. Pressure drop is the main calculation for piping. It will determine either fluid will flow smoothly and reach the next point of the pipe. For the calculation, initial pressure of air is 125 psi and deionized water is 18 psi. The pressure drop percentage must not exceed 30 percent or otherwise the fluid cannot reach the next point of pipe. As the result, the fluid will flow to the final point of pipe because the pressure drop percentage is not exceeding 30 percent. Piping materials also crucial for piping and it is depends on the type of fluid. Deionized water piping use cross linked polyethylene (PEX) because of it corrode resistant, resist with high temperature and will use only few fittings but air use smart pipe that made of 6035-T5 calibrated alloy aluminium and coated with blue powder that is non flammable and 100 percent recyclable. In conclusion, the new air and deionized water piping system can support the demand of additional equipments in FKKSA's laboratory.

ABSTRAK

Sistem perpaipan air tidak berion dan udara telah dilukis meggunakan ‘Plant Design Management System’ (PDMS). PDMS telah digunakan di seluruh dunia bukan sahaja untuk rekaan perpaipan tetapi juga untuk mereka kilang dan platfom di laut. Objektif utama untuk kajian ini adalah untuk menaiktaraf system paip sedia ada untuk memastikan ia boleh menampung peningkatan permintaan air tidak berion dan udara disebabkan pemasangan peralatan baru. Makmal Fakulti Kejuruteraan Kimia dan Sumber Asli (FKKSA) telah digunakan sebagai model untuk projek ini. Penurunan tekanan adalah pengiraan terpenting untuk perpaipan. Ia akan menentukan sama ada bendalir akan mengalir dengan lancar dan sampai ke titik paip seterusnya. Bagi tujuan pengiraan, tekanan bagi udara adalah 125 psi dan air tidak berion adalah 18 psi. Peratus penurunan tekanan mestila tidak melebihi 30 peratus atau bandalir tidak sampai ke titik seterusnya dalam paip. Bahan untuk membuat paip juga sangat penting dan ia bergantung kepada jenis bendalir. Air tidak berion menggunakan Polyethylene bersilang (PEX) kerana is tahan karat, tahan suhu tinggi dan menggunakan hanya sedikit penyambung tetapi udara menggunakan ‘Smart pipe’ yg dibuat menggunakan 6035-T5 aluminium aloi dan disalut menggunakan serbuk biru yang tidak terbakar dan 100 peratus boleh dikitar semula. Kesimpulannya, system perpaipan air tidak berion dan udara yang baru boleh menampung pemintaan disebabkan pemasangan peralatan tambahan di dalam makmal FKKSA.

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LIST OF ABBREVIATIONS AND SYMBOLS

PDMS	-	Plant Design Management System
FKKSA	-	Fakulti Kejuruteraan Kimia dan Sumber Asli
PEX	-	Cross Linked Polyethylene
PVC	-	Polyvinyl chloride
CPVC	-	Chlorinated Polyvinyl Chloride
NPS	-	Nominal Pipe Size
MS	-	Malaysian Standard
PE	-	Polyethylene
F	-	Fabricated
H	-	Strain Hardened
W	-	Solution Heat Treated
T	-	Heat Treatment
BC	-	Before Christ
m^3	-	Meter Cube
2D	-	2 Dimension
ΔP	-	Pressure Drop
P	-	Density
f	-	Friction Coefficient
L	-	Length
v	-	Velocity
^oF	-	Degree Farenheit
D	-	Internal Pipe Diameter
g	-	Gravitational Force

L	-	Length
ΔH	-	Vertical Elevation
kg	-	Kilogram
m	-	Meter
3D	-	3 Dimension
LNG	-	Liquid Natural Gas

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Piping is essential in many types of industries. It is used worldwide to transfer fluid either oil, gas and also water. In oil and gas industries, piping is used to transfer oil and gas from transmission line to distribution line. It has being choose as medium to transfer such those things because of cost if compare with gas than being transport with lorry. Other than that, piping can transfer gas easily without compression. For example, it is needed to have compression to transport LNG (Liquid natural gas), thus the cost will increase. Cost is very crucial in industries. All things that involve in industries deal with benefits, cost and safety.

In laboratories worldwide, piping has become heart for any process involve. Any equipments that involve process such as heat exchanger, reactor or spray dryer use piping to run the process. The type of piping material used is depends on fluid run through it. However, cost still must be the first consideration to choose material used in piping.

In piping, pressure drop is important to make sure either the fluid can reach the end point or not. The pressure demand for every end point is important to estimate the initial pressure. Other than that, the pipe length, diameter, elevation, flow rate and bending also influence the pressure drop. If one of this parameter is miss or wrong, neither the piping will broke down due to the high velocity of fluid nor fluid not reach end point due to high pressure drop.

Besides that, material used for piping must be taken as consideration depends on the usage of the piping. For water, Polyvinyl chloride (PVC) pipe, galvanized iron pipe and chromed copper used. Air use galvanized steel, copper and PVC for it piping. Normally, PVC is taken as first choice for piping materials compared with others because it is lighter and cheaper. Due to certain circumstances like high pressure fluid and place that need durable pipe material, it is recommended to used hardier pipe to avoid any hazard.

1.2 Problem statement

Recently, FKKSA's laboratory is using a lot of deionized water for running the equipments in the laboratory. For the time being, it can used to support the equipments needed. If there is other equipment installed in the laboratory, the piping maybe cannot support the new equipments. Thus, there must be new piping system design to make sure the demand can be fulfilled. Otherwise, there must be difficulties or damages occur when new equipments installed. There are many things to be considered to make sure the design suite with the demand. The pressure drop, pipe length, pipe material and the regulation and act must be considered or the will be other problem involve like machine cannot operate as expected or machine broke down.

1.3 Project objectives

The objectives of this project are:

1. To design new piping system in FKKSA's lab.

2. To make sure the fluid can reach the end point due to pressure drop.

3. To make sure the piping system meets MS1063:2002, Malaysian Standard for fluid piping requirements.

1.4 Scope of research project

In order to achieve the objective, the following scopes of research work have been made:

1) The piping specification

It is compulsory to know well about pipe specification, type of pipe material, diameter of the pipe and also the pipe length for Plant Design Management System (PDMS) matter. Besides that, the fluid that involve in new piping system design in FKKSA's laboratory is water and compressed air.

2) The pressure drop calculation

Pressure drop must be identified to make sure the fluid will reach endpoint. The pipe length, diameter, elevation, flow rate and bending also must be taken into account to make sure the calculation for pressure drop is accurate.

3) The safety aspect and requirements

The piping must follow MS1063:2002 that is Malaysian Standard for fluid piping. It is to make sure the air and piping system is in safe to be use.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of piping system

Piping is a system of pipes used to transport fluids (liquids and gases) from one location to another (Majid & Yaacob, 2001; McKetta & John, 1992). It is easy to transport the fluid using the piping system because piping can save cost, good in term of safety and easy to handle and maintain. Normally, for water, piping system is used from the pump house, go to the tower and distribute to residential, commercial and industrial customers. Other than that, gases like carbon dioxide or nitrogen is transfer normally from the storage tank placed in the building itself use piping system.

2.2 Design of pipeline

There are a few steps must to be done to establish pipeline system (Cornell et. al, 1959). The steps are:

1) Market survey

   Market survey is important to make sure the load demand needed. Load demand means the quantity of fluid needed by customers or equipments for operation. Besides that, in business, the important of market survey is to make sure company not having losses due to more expenditure from profit.

2) Pipe size and working

Pipe size can control the pressure of the pipe. Smaller pipe size or diameter contributes to high pressure of the fluid. There are standard pipe size called nominal pipe size (NPS). The nominal pipe size is based on inches. Wall thickness can be identified using NPS by referred to the pipe schedule.

Table 2.1: The list of NPS ⅛ to NPS 3½ wall thickness

Wall thickness inches (millimeters)							
NPS	**DN mm**	**OD inches**	**SCH 5**	**SCH 10**	**SCH 30**	**SCH 40**	**SCH 80**
⅛	**6**	0.405 in	0.035 in	0.049 in	0.057 in	0.068 in	0.095 in
¼	**8**	0.540 in	0.049 in	0.065 in	0.073 in	0.088 in	0.119 in
⅜	**10**	0.675 in	0.049 in	0.065 in	0.073 in	0.091 in	0.126 in
½	**15**	0.840 in	0.065 in	0.083 in	—	0.109 in	0.147 in
¾	**20**	1.050 in	0.065 in	0.083 in	—	0.113 in	0.154 in
1	**25**	1.315 in	0.065 in	0.109 in	—	0.133 in	0.179 in
1¼	**32**	1.660 in	0.065 in	0.109 in	0.117 in	0.140 in	0.191 in
1½	**40**	1.900 in	0.065 in	0.109 in	0.125 in	0.145 in	0.200 in
2	**50**	2.375 in	0.065 in	0.109 in	0.125 in	0.154 in	0.218 in
2½	**65**	2.875 in	0.083 in	0.120 in	0.188 in	0.203 in	0.276 in
3	**80**	3.500 in	0.083 in	0.120 in	0.188 in	0.216 in	0.300 in
3½	**90**	4.000 in	0.083 in	0.120 in	0.188 in	0.226 in	0.318 in

The table represent the standard nominal pipe size and and wall thickness for piping. The NPS is use in piping because there are inner and outer diameters for piping. It will way to choose piping become easier.

3) Pipe specification

Specification of the pipe means the material used, length and diameter of the pipe. The material used depend on the pressure involve and the fluid flow through the pipe.

4) Map of tentative route

The route of the pipe must be drawn first to make the pipe easily to construct. A systematic drawing must be drawn to make sure the position of the pipe is correct.

5) Total estimation of cost

Estimation of the cost is important for industries to know either the piping is profitable or not. The cost includes piping material, bending, process cost to combine the pipe and worker cost.

6) Construction

When all of the processes for piping construction accomplished, construction can be ran. Precaution must be taken to make sure construction is in safety condition.

7) Testing

After construction accomplished, testing must be ran to ensure the piping can be used and resist the pressure. Water can be used for testing because it is not dangerous.

8) Putting in service

After testing done, the piping will have last check and can be used. The piping must be maintained to make sure it is efficient to be used from day to day.

2.3 Standards and codes

For piping normally, the codes that being used are MS1063:2002 It is important to follow it to make sure the safety of people that involve in it and also the government acceptance for the piping.

2.3.1 Protection of pipeline from hazard

There are hazard that can happen accidently to pipeline such as flood and landslide. It will destroy the pipeline if the pipeline not construct properly. There are a few steps should be taken for precaution such as (Mohitpour, et. al., 2003) :

1) Constructing revetment

   Revetment used for piping protection from any physical damage. Normally, the revetment is placed if the pipeline is at underground.

2) Preventing corrosion

   Corrosion must be prevented to make sure it not reduce the efficiency of the pipe. Normally, the material used for water piping is material that not corrodes easily.

3) Increasing wall thickness

   Increasing wall thickness is important to protect piping. Increasing wall thickness will increase the cost of the project but for long term, it is good way for preventing hazard.

4) Installing anchor

   Anchor is clamp for pipe that used to protect pipe from hazard. Normally, anchor is used if piping is in the ground or beside wall.

It is important to make sure the steps are taken because any damage will increase the cost and cause losses.

2.3.2 Piping underground in the building

For piping under building, there are a few steps should be taken to prevent accident (Antaki, 2003). There are:

1) The piping should encase in an approved conduit designed to withstand the superimposed loads.
2) The piping should extend to the accessible and usable portion of building and the portion is conduit terminate.
3) The space between conduit and piping should be sealed
4) The piping that is touching the earth or the thing that can corrode it should be protected with suitable ways.

2.3.3 Pipe sizing for piping system

The sizing for piping system must follow several factors to make sure the piping in a condition (Antaki, 2003). The factors are length of piping, number of fitting, specific gravity of gas, diversity factor, prediction of future demand, maximum gas demand and allowable pressure loss from the supply point to equipment.

2.4 Plastic piping material

Plastic is strong and cheap material that can be used in piping. It is used for several type of fluid that not corrode it like water. It upper limit temperature is 150^{o}F (Willoughby & Woodson, 2002).

2.4.1 Polyvinyl chloride (PVC)

PVC is dangerous if it is in fire because it can release toxic gas. For code and standard, it is compulsory to follow the standard (Frankel, 2010) that is for interior water pipe pressure use D-2241, D-1785 and D-272, fittings use D- 2665 and plastic pipe and fittings use CS-272

2.4.2 Clorinated polyvinyl chloride (CPVC)

Modified from PVC and has extra chlorine on it, and can extent it temperature limit to 200^{o}F. It must follow the following standard (Frankel, 2010). For piping the standard used is ASTM D-2846, F-441 and F-442. For fitting standard used the F-437, F-438 and F-439

2.4.3 Polyethylene (PE)

Polyethylene is widely use for it superior toughness, ductility, flexibility and ability to dampen water shock. It can be used for gas distribution piping and potable water. The upper service temperature limit is 150^{o}F. It can be used within chemical because of it flexibility and normally used as drainage material. There are 4 types of PE pipe and it is classified as type 1, 2, 3 and 4 follow the density of resin used. The 4 is the

highest density is called HDPE. The normally used PE pipe is type 3 and 4 (Frankel, 2010).

2.4.4 Overall advantages of plastic pipe

Plastic pipe has it advantages based on the material involve. The advantages make it commonly used nowadays beside of it cost that cheapest compared to other material. The advantages of the plastic material are (Chasis, 1988):

1) Corrosion resistance

   Plastic is corrosion resistance because of it non conductivity. It can be buried in acidic and alkaline soil with no special casing.

2) Low thermal conductivity

   The advantages may give the plastic type resist any non-uniform temperature of fluid inside the pipeline.

3) Flexibility

   It can minimize the expansion or contraction because of it flexibility.

4) Low friction loss

   It can transfer fluid use less horsepower than metal and non-metallic pipe. Low friction loss and corrosion resistance make it can be use in small diameter and save cost.

5) Long life

   Due to it resistance to most of corrosion factors, it is long life. For example, there is 25 years installed plastic pipe be examined and there is only a little degradation found.

6) Lightweight

It is light and is easy to carry and the cost for transport and install can be reduced.

7) Colored piping

The plastic piping is easy to colored thus it is easy to labeled and identified

2.4.5 Non-Ferrous Pipe

Non-ferrous pipe and fitting materials are metallic materials with a non-iron matrix. For example, aluminium, copper and nickel.

1) Aluminium Alloys

Aluminum is obtained by mining and processing aluminum ore which contains aluminum oxide, iron, silicon and impurities. It is reactive with oxygen and forms a strong protective oxide layer. The 1000 series means pure aluminum, 2000 series means aluminium cuprum alloys, 3000 series means aluminium manganese alloys, 4000 series means aluminium silicone alloys, 5000 series means aluminium manganese alloys, 6000 series means aluminium carbon alloys, and 7000 series means aluminium zink alloys. The four digit number of Aluminum alloys is usually followed by a letter that identifies the type of heat treatment applied to the material. For example F is as-fabricated, H is strain hardened, W is solution heat-treated, T corresponds to other heat treatment.

2) Nickel Alloys

Nickel is a ductile metal, high strength and good corrosion resistance, it make the stainless steel, which is why close to half the production of nickel is used as stainless steel alloy. Nickel based alloys are valuable in corrosive or high temperature applications

3) Copper Alloys

Copper, bronze and brass have been used to make pipes as early as 3000 BC because they are soft, easy to form, and corrosion resistant in water service. A common copper tube material is ASTM B 88, available in three tubing sizes that is K, L and M.